

an underfill material between the semiconductor chip and the organic chip carrier, wherein the underfill material encapsulates the solder member, and wherein the underfill material has an elastic modulus of at least about 1 gigapascal.

20. An electronic structure, comprising:

a semiconductor substrate having a first electrically conductive pad thereon;
an organic substrate having a second electrically conductive pad thereon; and
a solder member electrically coupling the first pad to the second pad, wherein a distance from a centerline of the solder member to a closest lateral edge of the semiconductor substrate is at least about 0.40 mm.

REMARKS

Currently pending claims 1-6 , 9-18, and 20 are for consideration by the Examiner. Claim 19 is cancelled herein. No claims are amended herein in the present office action response.

The Examiner indicated that claims 7 and 8 are allowed. Applicants gratefully acknowledge the Examiner's indication of allowable subject matter.

The Examiner rejected claims 1, 2, 4, 9-13, 15 and 20 under 35 U.S.C. §103(a) as being unpatentable over Zhang et al., U.S. Patent 6,310,403B1 in view of Kanda et al., U.S. Patent 6,153,938.

The Examiner rejected claims 3, 5, 6, 14, 16 and 17 under 35 U.S.C. §103(a) as being unpatentable over Zhang et al., U.S. Patent 6,310,403B1 in view of Kanda et al., U.S. Patent 6,153,938 as applied to claims 1, 2 and 4 above, and further in view of Chung, U.S. Patent

6,399,178B1.

The Examiner rejected claims 18 and 19 under 35 U.S.C. §103(a) as being unpatentable over Zhang et al., U.S. Patent 6,310,403B1 in view of Chung, U.S. Patent 6,399,178B1.

Applicants respectfully traverse the §103 rejections with the following arguments.

35 U.S.C. §103(a): Claims 1-6, 9-17, and 20

The Examiner rejected claims 1, 2, 4, 9-13, 15 and 20 under 35 U.S.C. §103(a) as being unpatentable over Zhang et al., U.S. Patent 6,310,403B1 in view of Kanda et al., U.S. Patent 6,153,938.

Applicants respectfully contend that claim 1 is not unpatentable over Zhang et al. in view of Kanda, because Zhang in view of Kanda does not teach or suggest each and every feature of claim 1. For example, Zhang in view of Kanda does not teach or suggest “wherein a surface area of the first pad exceeds a surface area of the second pad.” The Examiner admits that “Zhang fails to teach wherein a surface area of the first pad exceeds a surface area of the second pad.” The Examiner alleges that “Kanda teaches wherein a surface area of the first pad exceeds a surface area of the second pad. See FIG. 1B of Kanda.”

Applicants disagree with the Examiner’s allegation that Kanda teaches that a surface area of the first pad exceeds a surface area of the second pad. First, Kanda’s disclosure does not discuss surface areas of pads. Second, FIG. 1B of Kanda shows only a cross-sectional view and does not show any pad surface area. In order to display a pad surface area, Kanda would have to display not only FIG. 1B but also a view of the pad in the direction perpendicular to the cross-sectional view of FIG. 1B. FIG. 1B only shows a line in the surface of each pad and does not

show the surface of any pad. Without knowing the extent of each pad's surface in said perpendicular direction, there is no way to know how the surface areas of different pads compare in magnitude from FIG. 1B. Additionally even if the pad surfaces were displayed in the Figures of Kanda (which they are not), any comparison of surface areas from Figures of Kanda without support from the disclosure would not be persuasive, because dimensions in Figures of patents are generally not assumed to be drawn to scale.

Additionally, even if it is assumed that Kanda teaches that a surface area of the first pad exceeds a surface area of the second pad (which Kanda doesn't teach), the Examiner has not presented a persuasive reason for combining Kanda with Zhang. The Examiner alleges: "In view of Kanda, it would have been obvious to one of ordinary skill in the art to incorporate the surface area of the first pad exceeding a surface area of the second pad in the Zhang semiconductor device because the semiconductor chip is flipped over so that the formed bumps are ready to be pressed against a substrate having electrodes (column 6, lines 15-18)." Applicants contend that the preceding cite of column 6, lines 15-18 from Kanda does not demonstrate a benefit to Zhang from anything taught by Kanda. The Examiner has merely cited lines from Kanda without presenting any analysis to show its relevance to Zhang's disclosure. Additionally, Applicants contend that the Examiner has not presented any evidence that Kanda discloses that having a surface area of the first pad exceed a surface area of the second pad has any effect on the ability to press forced bumps against the pads of the organic substrate. Kanda does not anywhere discuss the effect of pad surface area on pressing bumps on substrates. Indeed, Kanda does not anywhere discuss surface areas of pads. Thus, Applicants contend that the Examiner has not made a *prima facie* case for obviousness in relation to claim 1 and the rejection of claim 1 is

therefore improper.

Based on the preceding arguments, Applicants respectfully maintain that claim 1 is not unpatentable over Zhang et al. in view of Kanda et al., and that claim 1 is in condition for allowance. Since claims 2-6 depend from claim 1, Applicants contend that claims 2-6 are likewise in condition for allowance.

Applicants respectfully contend that claim 9 is not unpatentable over Zhang et al. in view of Kanda, because Zhang in view of Kanda does not teach or suggest each and every feature of claim 9. For example, Zhang in view of Kanda does not teach or suggest “wherein a surface area of the first pad exceeds a surface area of the second pad by a factor of at least about 1.2”. Applicants’ arguments that Zhang in view of Kanda does not teach or suggest the preceding feature of claim 9 and that the Examiner has not presented a *prima facie* case for combining Kanda with Zhang are essentially the same arguments as was presented *supra* in relation to claim 1.

In addition, the Examiner stated that he does not consider the preceding factor of “at least about 1.2” as having patentable significance. In response, Applicants point out that the ratio S_1/S_2 , where S_1 and S_2 is the surface area of first pad and second pad, respectively, is a novel feature of the present invention relating to extending fatigue life of the interface between the solder member and the first pad. See Specification, page 5, lines 7-13 for a discussion of how S_1/S_2 affects said fatigue life. See Specification, page 9, line 14 - page 8, line 9 for a discussion of test data demonstrating the effect on fatigue life of varying S_1/S_2 . Accordingly, Applicants maintain that claimed ranges of S_1/S_2 is novel and not obvious. Based on the preceding

arguments, Applicants respectfully maintain that claim 9 is not unpatentable over Zhang in view of Kanda, and that claim 9 is in condition for allowance.

Applicants respectfully contend that claim 10 is not unpatentable over Zhang et al. in view of Kanda, because Zhang in view of Kanda does not teach or suggest each and every feature of claim 10. For example, Zhang in view of Kanda does not teach or suggest “wherein a surface area of the first pad exceeds a surface area of the second pad by a factor between about 1.1 and about 1.3”. Applicants’ arguments that Zhang in view of Kanda does not teach or suggest the preceding feature of claim 10 and that the Examiner has not presented a *prima facie* case for combining Kanda with Zhang are essentially the same arguments as was presented *supra* in relation to claim 1.

In addition, the Examiner stated that he does not consider the preceding factor of “between about 1.1 and about 1.3” as having patentable significance. In response, Applicants point out that the ratio S_1/S_2 , where S_1 and S_2 is the surface area of first pad and second pad, respectively, is a novel feature of the present invention relating to extending fatigue life of the interface between the solder member and the first pad. See Specification, page 5, lines 7-13 for a discussion of how S_1/S_2 affects said fatigue life. See Specification, page 9, line 14 - page 8, line 9 for a discussion of test data demonstrating the effect on fatigue life of varying S_1/S_2 . Accordingly, Applicants maintain that claimed ranges of S_1/S_2 is novel and not obvious. Based on the preceding arguments, Applicants respectfully maintain that claim 10 is not unpatentable over Zhang in view of Kanda, and that claim 10 is in condition for allowance.

Applicants respectfully contend that claim 11 is not unpatentable over Zhang in view of Kanda, because Zhang in view of Kanda does not teach or suggest each and every feature of claim 11. For example, Zhang in view of Kanda does not teach or suggest “wherein a surface area of the first pad exceeds a surface area of the second pad by a factor between about 1.3 and about 2.0”. Applicants’ arguments that Zhang in view of Kanda does not teach or suggest the preceding feature of claim 11 and that the Examiner has not presented a *prima facie* case for combining Kanda with Zhang are essentially the same arguments as was presented *supra* in relation to claim 1.

In addition, the Examiner stated that he does not consider the preceding factor of “between about 1.3 and about 2.0” as having patentable significance. In response, Applicants point out that the ratio S_1/S_2 , where S_1 and S_2 is the surface area of first pad and second pad, respectively, is a novel feature of the present invention relating to extending fatigue life of the interface between the solder member and the first pad. See Specification, page 5, lines 7-13 for a discussion of how S_1/S_2 affects said fatigue life. See Specification, page 9, line 14 - page 8, line 9 for a discussion of test data demonstrating the effect on fatigue life of varying S_1/S_2 . Accordingly, Applicants maintain that claimed ranges of S_1/S_2 is novel and not obvious. Based on the preceding arguments, Applicants respectfully maintain that claim 11 is not unpatentable over Zhang in view of Kanda, and that claim 11 is in condition for allowance.

Applicants respectfully contend that claim 12 is not unpatentable over Zhang in view of Kanda, because Zhang in view of Kanda does not teach or suggest each and every feature of claim 12. For example, Zhang in view of Kanda does not teach or suggest “wherein a

distance from a centerline of the solder member to a closest lateral edge of the semiconductor substrate is at least about 0.25 mm..” The Examiner has not provided any argument that Zhang in view of Kanda teaches or suggests the preceding feature of claim 12. In fact, the Examiner has not even alleged that Zhang in view of Kanda teaches or suggests the preceding feature of claim 12. Applicants point out that the distance from a centerline of the solder member to a closest lateral edge of the semiconductor substrate is a novel feature of the present invention relating to extending fatigue life of the interface between the solder member and the first pad. See Specification, page 8, line 10 - page 10, line 19 for a discussion of test data demonstrating the effect on fatigue life of varying the distance from a centerline of the solder member to a closest lateral edge of the semiconductor substrate. Accordingly, Applicants maintain that claimed ranges relating to said distance is novel and not obvious. Based on the preceding arguments, Applicants respectfully maintain that claim 12 is not unpatentable over Zhang in view of Kanda, and that claim 12 is in condition for allowance. Since claims 13-17 depend from claim 12, Applicants contend that claims 13-17 are likewise in condition for allowance.

As to claim 20, Applicants respectfully contend that the Examiner has not presented any argument in support of the rejection of claim 20. Thus, Applicants contend that the Examiner has not made a *prima facie* case for obviousness in relation to claim 20 and the rejection of claim 20 is therefore improper.

35 U.S.C. §103(a): Claim 18

The Examiner rejected claim 18 under 35 U.S.C. §103(a) as being unpatentable over Zhang et al., U.S. Patent 6,310,403B1 in view of Chung, U.S. Patent 6,399,178B1.

Applicants respectfully contend that claim 18 is not unpatentable over Zhang in view of Chung, because Zhang in view of Chung does not teach or suggest each and every feature of claim 18. For example, Zhang in view of Chung does not teach or suggest “wherein a distance from a centerline of the solder member to a closest lateral edge of the semiconductor substrate is at least about 0.25 mm”. The Examiner has presented no argument supporting that Zhang in view of Chung teaches or suggests the preceding feature of claim 18. In fact, the Examiner admits that “Zhang fails to disclose the dimensions” Thus, Applicants contend that the Examiner has not made a *prima facie* case for obviousness in relation to claim 18 and the rejection of claim 18 is therefore improper.

Additionally, Zhang in view of Chung does not teach or suggest “wherein the underfill material has an elastic modulus of at least about 1 gigapascal”. The Examiner admits that “Zhang fails to disclose ... wherein the underfill material has an elastic modulus of at least about 1 gigapascal.” The Examiner alleges that Chung discloses an underfill material with an elastic modulus of at least about 1_ gigapascal. Although Chung discloses the elastic modulus of the underfill material in units of psi (i.e., 2,000,000 psi, column 18, line 61) it is equivalent to Applicants units. In view of Chung, it would have been obvious to one of ordinary skill in the art to incorporate the elastic modulus of Chung into the Zhang semiconductor device because the rigid adhesive underfill perform is aligned with the substrate (column 14, lines 48-53). ”

Applicants note that column 14, lines 48-53 of Chung states: “Rigid adhesive underfill preform 110 is aligned with substrate 30 so that the pattern of solder columns 134 of preform 110

corresponds with the pattern of contact pads 132 of substrate 30.” Thus, column 14, lines 48-53 of Chung merely describes how rigid adhesive underfill preform 110 is aligned with substrate 30, but does not provide a reason for the modulus of at least about 1 gigapascal as required by claim 18. Moreover, the preceding statement in Chung does not provide any motivation for a modulus of at least about 1 gigapascal in the underfill 310 in Zhang, and the Examiner has provided no analysis to support why a person of ordinary skill in the art would use an underfill having modulus of at least about 1 gigapascal in the underfill 310 in Zhang. In col. 6, lines 6-10, Zhang states: “after the assembly process, an underfill material 310 is dispensed or injected between substrates 110 and 190 to package or encapsulate the interconnect bumps and the first and second pluralities of interconnects. Material 310 protects the bumps from becoming over stressed during subsequent temperature cycles.” Applicants contend that there is no reason, based on the preceding statement in Zhang, why a person of ordinary skill in the art would use an underfill having modulus of at least about 1 gigapascal in the underfill 310 in Zhang. Thus, the combination of Zhang and Chung is not obvious.

Based on the preceding arguments, Applicants respectfully maintain that claim 18 is not unpatentable over Zhang in view of Chung, and that claim 18 is in condition for allowance.

CONCLUSION

Based on the preceding arguments, Applicants respectfully believe that claims 1-6, 9-18, and 20 and the entire application meet the acceptance criteria for allowance, and therefore request favorable action. If the Examiner believes that anything further would be helpful to place the application in better condition for allowance, Applicants invite the Examiner to contact Applicants' representative at the telephone number listed below.

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